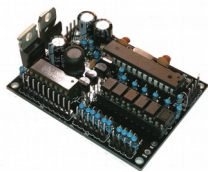# Arduino Nixie Clock

"Classic Rev4 and Rev5"
"All In One"
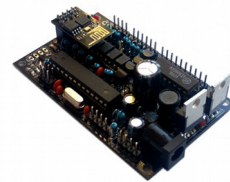
Operating Instructions
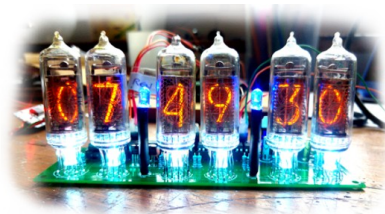# Firmware V56

Supported Models:

"Classic Rev4 (6 digit)"

"Classic Rev5"

"All-In-One"

Table of Contents

About this document

This is the user instruction manual for the Nixie Clocks shown on the first page

- Classic Revision 4 (6-Digit firmware)
- Classic Revision 5
- All-In-One

All of these clocks use the same firmware.

If you want to have the construction manual to guide you through the process of building the clock, please find the appropriate manual at:

https://www.nixieclock.biz/Manuals.html

There should have been an exact link to the clock manuals on the packing skip you received in the package.

Contact Information

If you want to get in contact with us, please email to:

nixie@protonmail.ch

We'll usually get back to you right away. We can help you with kits or construction.

We also offer discounts for direct purchases, we save the Ebay fees, and share this with you.

http://www.nixieclock.biz/Store.html

There is also a forum for the clocks, where you can find many answers to questions and contact others who are also using the clocks at:

http://bit.ly/2omqPRr

Which should redirect you to the much longer:

https://www.tubeclockdb.com/component/kunena/12-arduino-nixie-clock-kit-support-forum.html

Firmware

The firmware is open source and you can install new versions on the clock if you wish, or even change the firmware to suit you own tastes or needs.

The source code is available on GitHub at the address:

https://bitbucket.org/isparkes/nixiefirmwarev1/src/master/

Description

The Arduino Nixie Clock is a beautiful mix of old and new, resulting in a high accuracy, low power clock which will be a talking point in your home.

The clock has the following features:
- Latest technology, highly reliable and accurate.
- Tried and tested design, with many hundreds of clocks sold.
- Based on the Arduino micro-controller: Easy to program an well documented.
- Open source! Nothing is hidden in this clock. (You may modify and load the software if you want to).
- Low power consumption.
- Long tube life: Anti Cathode Poisoning (ACP) and configurable blanking makes sure that the tubes will stay healthy for many years with no intervention from you.
- The multiplexed display and automatic dimming used in this design extends the life of the tubes indefinitely. Some other designs run the tubes too "hard", and this causes a rapid degradation in the useful life of the tube.
- All settings are stored in non-volatile memory. Once they are set, they are remembered forever, or until you change them again.
- RGB back lighting allows you to set the the color of the back lighting to practically any color you desire.
- Ambient light sensing, with automatic tube dimming, which sets the tube and LED brightness according to the light conditions. This also increases tube life.
- Absolutely silent operation. Some Nixie clocks emit an irritating "buzz" or "hiss" which is especially annoying if you keep the clock in a bedroom.
- Automatic week day or weekend blanking, extends the life of tubes even further
- Automatic time of day blanking, can blank between a start hour and an end hour, on week days, weekends or every day
- Configurable suppression of Anti Cathode Poisoning when the clock is fully dimmed. In the middle of the night, all the digits lighting up at full brightness could be disturbing. You can choose to stop ACP when the clock is fully dimmed
- The High Voltage Generator auto-calibrates itself to match your tubes and power supply, meaning that the power consumption is the lowest possible. (Usually 2W when fully bright, 0.4W when blanked).
- Highly accurate when using RTC module:
    - Battery backed, temperature compensated, high accuracy clock. The accuracy is Accuracy ±2ppm from 0°C to +40°C. (Maximum 1 minute per year).
    - The battery life should be 3 years in normal use.
    - Retains the date and time even when turned off (not just for a few minutes, but for as long as the battery lasts)
    - Leap Year Compensation Valid Up to the year 2100
- Extremely accurate when using the optional Wifi module:
    - The time never drifts, is always right to within 1 second.
    - Automatically compensates for Daylight Savings Time changes, leap years and seconds.
- It is possible to use the RTC and the WiFi module together. In this case, the WiFi module will be used when it is available, otherwise the RTC module will be used. The RTC automatically gets set to the right time when the WiFi module is available.
- The controller can be programmed without removing it from the board, due to the ICSP port on the board ("Classic" clock).

Safety

The voltages produced in the High Voltage circuit can reach peaks of 400V! Take precautions not to electrocute yourself! If you are not sure what this means, please do not use this clock and return it for a full refund.

A shock from the clock high voltage circuit is at least a nasty bite. At worst it can kill you.

We decline any responsibility in the case of injury or death. You must be qualified to use this clock, it is not intended for anyone unqualified.

REPEAT: If you are not sure what this means, do not use the clock!

General

The clock has different modes of operation, which you select using the push button.

First Start and calibration

When you start the clock up the very first time, it will start in "First Start Mode". This mode is intended to simplify the set up of the hardware. It cycles through the digits 00:00:00 - 99:99:99 and drives the High Voltage Generator with a basic setting which does no dimming. This allows you to check that all digits on all tubes are working correctly.

Note!

Test Mode will only keep the High Voltage running for 60 seconds!

After 60 seconds the High Voltage generator will be turned off to protect the circuit. To re-enable the high voltage, you should power the clock off and on again.

Exit First Start mode

Once you have mounted the tubes and are happy that they are working well, you can exit "First Start Mode".

To **EXIT First Start Mode, press the push button when the display shows "88:88:88", and the clock will enter calibration mode!**

The clock will go through the calibration routine. The display will start dimly, then count up, display 88:88:88 for several seconds. This is for the calibration of the High Voltage Generator to match the power adapter you have attached. During this time you might hear some faint crackling noises from the generator. This is normal.

After finishing the calibration, the version number ("00:56:00") will be displayed for about a second. The clock will then go into normal operating mode.

You will use this function when you are building the High Voltage circuit.

Once you have exited First Start Mode, it will not enter it again until you do a factory reset (See below).

Clock Mode

After the first start, each time you start up the unit, the clock will go into normal clock mode and will display the time. In normal clock mode, the time will be displayed.

Every 10 minutes (at "xx:x9:15", the clock will do "Anti-Cathode Poisoning", which will cycle all the digits for about 10 seconds.

This is not an error! It is important to keep the tubes healthy in the long term.

Factory Reset

If you want to go back to first start or calibration mode, you can perform a factory reset on the clock. To do this, hold down the button while you power on. This will reset all settings and start up the clock in First Start Mode again.

This is useful if you need to re-calibrate the HV generator, or want to reset all configurations again.

Time Providers

The clocks can use a battery backed RTC module or a WiFi module. You can also install both, and in this case, please read the section on "Fallback from WiFi to RTC" below.

Real Time Clock

By default, the clock comes with a Real Time Clock (RTC) module which provides a battery backed time source that remembers the time even when the clock is not powered up.

WiFi Time Providers

More up to date is a WiFi real time provider, which logs into your home WiFi network and periodically retrieves the time from Internet time sources. These are accurate to 1 second, and auto adjust for Daylight Savings Time. You configure once, and then the module remembers the configuration forever.

Additionally, the WiFi time module gives you a easy to configure interface, which you can use to set up the clock using a tablet, phone or computer.

Fallback from WiFi to RTC

If you install both the WiFi and the RTC modules, the RTC will be used only when the WiFi unit is not able to synchronize with the Internet! RTC time is updated periodically from the Internet time, and therefore uses the RTC as a back up only when WiFi time is not available. Fallback happens after 5 minutes of missing WiFi time. Recovery happens as soon as WiFi is available again.

Overview

Normally the clock is in "Time Display Mode", which will show the time. If you press the button for differing lengths, different things will happen.

"Short Press" (less than 1 second): A temporary display will be shown for 5 seconds. This is useful if you want to know the date, for example. The options here are given in the section "Temporary Display Mode"

"Medium Press" (more than 1 second): The clock will go into "Setting Mode" to allow you to change settings. If you have the WiFi module, you can change settings using a browser.

"Long Press" (more than 8 seconds): The clock will go into "Tube healing mode". **Read the section on "Tube healing Mode" before using this mode.** This mode can damage your tubes if you don't use it correctly!

Temporary Display Mode

Normally, the clock will show the time. To show additional information press the button with a "short" press. Each press cycles through the following information. After 5 seconds, the display will revert to the normal time display.

Note that some of the options are not shown under all circumstances. For example, if you are not connected to a WiFi access point, the IP address will not be shown.

Mode	Description	Values
Date	**Date.** The current date will be shown in the date format you selected.	Example "17.06.18"
Temp	**Temperature / Time Provider Module status.** SS (the seconds digits) can have 4 values: "10": The clock does not have a time provider installed, and is working off the internal time source. (Not accurate) "11": The clock has an RTC time source installed. "12": The clock has a WiFi time source installed. "13": The clock has a WiFi and an RTC time source installed In modes "11" and "13" the digits "TT:tt" (hours and minutes) will show the temperature, to the nearest ¼ degree, where "TT" is whole degrees, and "tt" is fractional degrees. In modes "10" and "12" the temperature is shown as "00:00". The temperature shown is the current temperature inside the clock casein degrees Celsius. If this goes above 40, you should consider ventilating the case, because the temperature compensation is not able to work at such high voltages, and the clock life may be reduced.	"TT:tt:SS" Example: "22:25:13" Means "22.25 Degrees WiFi and RTC installed"
LDR	**Ambient Light Reading.** This shows the current ambient light reading from the LDR (light dependent resistor). It is a normalized value, and goes between 100 (dark) to 999 (bright). This controls the dimming of the tubes. (See also the section on "Min Dim" later in the manual).	Example "01:00:--" 100: darkest 999: brightest
Version	**Version number.** The format will be :"VV vv 07", where major version is "VV", minor version is "vv" and the "21" is the id for the version display.	Example "00:55:--"
IP Address part 1	If you have the WiFi module connected, this will show the first two digits of the 4 digit IP address. Usually this address starts with "192.168". **Note:** The IP address is skipped if you do not have the WiFi module connected.	Example: "19:21:68" = "192.168"
IP Address part 2	If you have the WiFi module connected, this will show the last two digits of the 4 digit IP address. Put this together with the value shown in IP Address part 1 to give the full address. You can enter the whole value into your browser to connect to the module. You must remove any leading "0" from the value. If you receive "192.168.001.106", you must enter this as "192.168.1.106" into your browser address bar.	Example: "00:11:06" = "001.106"
Mux	This shows the number of impressions per second, which is the	Example:

Speed	refresh rate of the display. It varies a little based on the exact workload, but is usually about 100 impressions per second.	"01:02:--"

Setting Mode

To enter setting mode, press the button for more than 1 second ("medium press"). The "RGB back light" LEDs will start to flash white. The number of consecutive flashes indicates the mode you are in.

Each medium press of more than 1 second will move the setting mode onto the next. When you finish the setting modes, the clock returns to normal time display mode.

To exit the setting mode before going through all the options, press the button for more than 2 seconds ("long press"). The "RGB back light" LEDs will return back to their normal operation. Another way of exiting is to cycle through all of the setting options, after which you will return to time mode.

To change a setting, press the button for less than one second, and then release it ("short press").

Time Settings

Mode	Description	Values
	Time mode. This is the normal mode and displays the time. It is the normal start up mode of the clock. If you do nothing. The clock is in this mode. In this mode a short press cycles through the values given in "Time Display Mode", but always returns to the standard time display after 5 seconds.	
Time and Date Settings		
Note that the Time and Date settings will not be shown if the WiFi module is active! There is no need to set the time manually in this case.		
	Set Hours. Each short press will advance the hour. The hours roll over back to zero after reaching 12 or 24 (depending on the 12/24 hours mode).	
	Set minutes. Each short press will advance the minute. The minutes roll over back to 0 ffter reaching 59 minutes. Each time you set the minute, the seconds is reset to 0.	
	Reset seconds. Each short press will reset the seconds to 0, without changing the hours or minutes.	
	Set Day. Each short press will advance the day. The day roll over back to one after reaching the maximum number of days in the month.	
	Set Month. Each short press will advance the month. The month roll over back to zero after reaching 12.	
	Set Year. Each short press will advance the year. The year roll over back to 2015 after reaching 2099.	

Basic Settings

Mode	Description	Values
Basic Settings		
"--:--:07" flashing	**12 or 24 hour time.** The hours are displayed in 12 or 24 hour mode.	"1" = 12 hour "0" = 24 hour default: 0
"--:--:08" flashing	**Blank leading "0".** Blank out the leading "0" from single digit hours.	"1" = blank "0" = don't blank default: 0
"--:--:09" flashing	**Scroll back.** Use the scroll back (rapid count down) effect when changing from "9" to "0". The speed of the scrollback is set by the "Scroll Speed" option.	"1" = enable "0" = disable default: 0
"--:--:10" flashing	**Fade.** Use cross digit fading. The speed of the fade is set by the "Fade Speed" option.	"1" = enable "0" = disable default: 0
"--:--:11" flashing	**Date format.** Set the format that the date is displayed in.	"0" = YY.MM.DD "1" = MM.DD.YY "2" = DD.MM.YY default: 2
"--:--:12" flashing	**Display blanking.** To preserve the tubes, you can set the display to be blanked. Options: • "0" = "never": Don't use blanking. • "1" = "Weekends": Blank at weekends. • "2" = "Week days": Blank on week days. • "3" = "Always": Always use blanking. • "4" = "Hours": Blanks between the start and end hour every day. • "5" = "Hours or weekends": This blanks all day during the weekends and between the start and end hour every other day. • "6" = "Hours or week days": This blanks all day during the week days and between the start and end hour every other day. • "7" = "Hours on weekends": This blanks between the start and end hour on weekends. • "8" = "Hours on week days": This blanks between the start and end hour on week days.	"0" = Don't blank "1" = Weekends "2" = Week days "3" = Always "4" = Hours "5" = H **or** weekends "6" = H **or** week days "7" = H **on** weekends "8" = H **on** week days default: 0
"--:--:13" flashing	**Blanking Hour Start.** Hour blanking will start at this hour, on the days set by the Display Blanking Mode. This value is always set in 24h format, even if the clock displays in 12H format. **Note:** If the display blanking mode is not enabled or does not use hours, this setting is not shown.	Default: 00
"--:--:14" flashing	**Blanking Hour End.** Hour blanking will end at this hour, on the days set by the Display Blanking Mode. This value is always set in 24h format, even if the clock displays in 12H format. **Note:** If the display blanking mode is not enabled or does not use hours, this setting is not shown.	Default: 07

Mode	Description	Values
"--:--:15" flashing	**Anti Cathode Poisoning night suppression.** The ACP which runs during the night lights the digits up at full brightness, and some people might find this disturbing. Using this setting, you can stop ACP happening when the display is fully dimmed (e.g. at night).	"1" = don't do ACP when dimmed "0" = do ACP always default: 1

Special Effects Settings

Mode	Description	Values
Special Effects Settings		
"--:--:16" flashing	**Use LDR**. If you disable the LDR, the tubes will always work at maximum brightness.	"1" = enable "0" = disable default: 1
"--:--:17" flashing	**Blank Mode.** You can set the tubes, the LEDs or both the tubes and the LEDs to be blanked when in blanking mode.	"0" = tubes "1" = LEDs "2" = tubes and LEDs default: 2
"--:--:18" flashing	**Fade Speed Slower**. Each short press will make the fade speed between digits slower.	Default: 50 Max: 200 Min: 20
"--:--:19" flashing	**Fade Speed Faster**. Each short press will make the fade speed between digits faster.	Default: 50 Max: 200 Min: 20
"--:--:20" flashing	**Scroll-back Speed Slower.** Each short press will make the "scroll-back" speed slower.	Default: 4 Max: 40 Min: 1
"--:--:21" flashing	**Scroll-back Speed Faster.** Each short press will make the "scroll-back" speed faster.	Default: 4 Max: 40 Min: 1
"--:--:22" flashing	**Slots Mode.** You can have the date shown automatically once per minute for about 5 seconds.	"1" = enable "0" = disable default: 1

Back Light Settings

Mode	Description	Values
Back Light Settings		
"--:--:23" flashing	**Back Light Mode.** This sets the mode of the back light. "Fixed" mode will show the back light color according to the Red, Green and Blue channel intensities. "Pulse" will make the intensity of the back light "pulse", brightening for a second and then darkening for a second, but always respecting the relative intensities set by the Red, Green and Blue channel intensities. "Cycle" fades the back lighting randomly, and does not use the Red, Green and Blue channel intensities. These settings will be skipped if cycle mode is selected. Options "0", "1" and "2", do not dim with the bulbs. Options "3", "4" and "5" do.	"0" = Fixed "1" = Pulse "2" = Cycle "3" = Fixed/Dim "4" = Pulse/Dim "5" = Cycle/Dim default: 0
"--:--:24" flashing	**Red Channel Intensity.** Sets the maximum intensity of the red channel back light. This will be dimmed according to the display dimming. **Note:** If you are in cycle mode, this setting will be skipped.	Default: 15 Max: 15 Min: 0
"--:--:25" flashing	**Green Channel Intensity.** Sets the maximum intensity of the green channel back light. This will be dimmed according to the display dimming. **Note:** If you are in cycle mode, this setting will be skipped.	Default: 0 Max: 15 Min: 0
"--:--:26" flashing	**Blue Channel Intensity.** Sets the maximum intensity of the blue channel back light. This will be dimmed according to the display dimming. **Note:** If you are in cycle mode, this setting will be skipped.	Default: 0 Max: 15 Min: 0
"--:--:27" flashing	**Cycle Speed.** If you are in cycle mode, this controls the speed at which the colors cycle. The higher the number, the slower the colors will change. **Note:** If you are not in cycle mode, this setting will be skipped.	Default: 10 Max: 64 Min: 4

HV Generation settings

Mode	Description	Values
HV Generation Settings (See "HV Settings" note)		
"--:--:28" flashing	**HV Target Voltage Higher.** Each press sets the HV target voltage higher by 5V.	Default: 180 Max: 200 Min: 150
"--:--:29" flashing	**HV Target Voltage Lower.** Each press sets the HV target voltage lower by 5V.	Default: 180 Max: 200 Min: 150
"--:--:30" flashing	**PWM On Time Longer.** This setting controls how long the PWM On pulse is. Normally you should not have to change this, but you can try changing this is the HV generation is noisy or you have unusual tubes.	Default: 150 Max: 50 Min: 500
"--:--:31" flashing	**PWM On Time Shorter.** This setting controls how long the PWM On pulse is. Normally you should not have to change this, but you can try changing this is the HV generation is noisy or you have unusual tubes.	Default: 150 Max: 50 Min: 500
"--:--:32" flashing	**Increase Minimum dim.** This setting allows you to increase the minimum brightness you want to have when the clock is fully dimmed.	Default: 100 Max: 500 Min: 100
"--:--:33" flashing	**Decrease Minimum dim.** This setting allows you to decrease the minimum brightness you want to have when the clock is fully dimmed.	Default: 100 Max: 500 Min: 100
"--:--:34" flashing	**Increase Anti-ghosting.** This setting reduces "ghosting" (the number on the right shows faintly on the digit on the left). This is due to transients when switching.	Default: 0 Max: 50 Min: 0
"--:--:35" flashing	**Decrease Anti-ghosting.** This setting reduces "ghosting" (the number on the right shows faintly on the digit on the left). This is due to transients when switching.	Default: 0 Max: 50 Min: 0

Note "HV Settings": Before leaving the clock for long periods with a new "HV Generation" setting, check that neither the MOSFET nor the voltage regulator is running too hot. If either of these components gets too hot, either adjust the high voltage settings or add a heat sink.

Information settings

Mode	Description	Values
Information Settings		
"––:––:36" flashing	**Current case temperature.** Show the current temperature inside the case (used as part of the temperature compensation for the clock crystal). **Note:** This will show 0 if the RTC is not installed.	
"––:––:37" flashing	**Clock version.** Show the clock software version.	
	Digit Test. Will roll through all digits on all locations to check that the display is healthy.	

Display Blanking Mode

During display blanking mode the tubes will be off depending on the display blanking settings. You can choose if you want the blank the LEDs, the tubes, or both the LEDs and the tubes.

You can configure the display to blank at weekends, during week days, always or never (the default). Also you are able to define hours during which to blank. For example I have a setting saying that the clock is blanked on weekdays between 7am and 4 pm, while I am out at work. At weekends, the display runs all the time.

Blanking override

Sometimes you will want to override the blanking, for example normally you have a clock at home that blanks during the day while you are at work, but on a holiday you are at home. In this case it is possible to temporarily override the blanking.

Press the button ("short press") while the clock is blanked, and the display will come on again for a few seconds, and then return to blanking mode.

If you press the button multiple times within 5 seconds, the blanking will stay off for longer periods:

- 1 Press: 10 seconds
- 2 Presses: 1 hour
- 3 Presses: 4 hours

Tube Healing Mode

After a long period of time, tube filaments which are not often used (e.g. the "9" on the tens of hours or minutes) can get dim, despite the ACP that is regularly done.

If you make a "long" press of the button (more than 8 seconds), the clock will enter filament healing mode. All the power will be placed through a single filament of a single digit to clean it. A short press will change the selected filament.

Another super-long press or cycling through all the filaments will return the clock to normal.

Caution! Don't leave a single filament in this state for an extended period of time. It is a harsh process, and may damage the tube if you leave it in this mode for too long. Normally a few seconds minutes will restore the cathode digit.

Normally you will not need to use this mode! It is only there for tubes that are already in trouble. **Don't make a habit of using this mode!**

Factory Reset

To reset the clock back to initial settings, hold down the button while powering on. The LEDs will rapidly flash some colours to signal that the reset has been done.

Everything will be reset back to the factory default state, and the clock will go back to "First Start Mode".

External power supply

The perfect voltage for the external power supply is 7.5V or 9V DC. You can use 12V DC.

If you use more than 12V be aware that you might have to provide a heat sink for the power components and adjust the HV voltage generation. It is not advised to use more than 12V.

The absolute maximum permissible is 16V DC. Higher voltages than this will surely damage the clock.

WiFi Interface

If you have the optional WiFi interface (highly recommended), you can perform the configuration of the clock using a comfortable web interface from your browser or phone.

Getting into the WiFi Module

For initial set up of the WiFi module, please see the WiFi Module User Manual.

Note!

Clock Configuration

The clock configuration page largely follows the options previously described. The HV settings are not available via the GUI interface, as these are not usually needed to be changed once they are set up, and fiddling with them can cause the clock to overheat.

For a full description of each option in the menu, please see the equivalent description in the "button menu" above.

Time Configuration

Please see the section in the WiFi Module User Manual. If you configure the module, it will not be necessary to ever set the clock again.

Utilities

The utilities page allows you to reset the configuration and update the WiFi Module firmware. Please see the section in the WiFi Module User Manual.

Revisions:

V0047: 22Jun2017: Split user manual and construction manual
V0048: 16Jul2017: Update for V48
V0051: 24May2018: Update for V51
V0052: 15Jun2018: Update for V52, new Nixie font
V0056: 03Jan2019: Update for V56
V0056: 15Sep2019: Correct hyperlink for store
V0056: 06Oct2020: Correct mode numbering – thanks Hal
V0056: 09Oct2020: Clarifications about blanking time settings being in 24H format